PATENT COOPERATION TREATY

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To:

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Date of mailing (day/month/year)
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111933 PA

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1. The following indications appeared on record concerning:

[ ] the applicant [ ] the inventor [X] the agent [ ] the common representative

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3. Further observations, if necessary:

4. A copy of this notification has been sent to:

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[X] the elected Offices concerned
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The International Bureau of WIPO
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1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

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PATENT COOPERATION TREATY

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

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Date of mailing (day/month/year) 28 February 2001 (28.02.01)	
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Applicant HÖJER, Svante et al	

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[X] in the demand filed with the International Preliminary Examining Authority on:

11 January 2001 (11.01.01)

[ ] in a notice effecting later election filed with the International Bureau on:

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made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer C. Cupello
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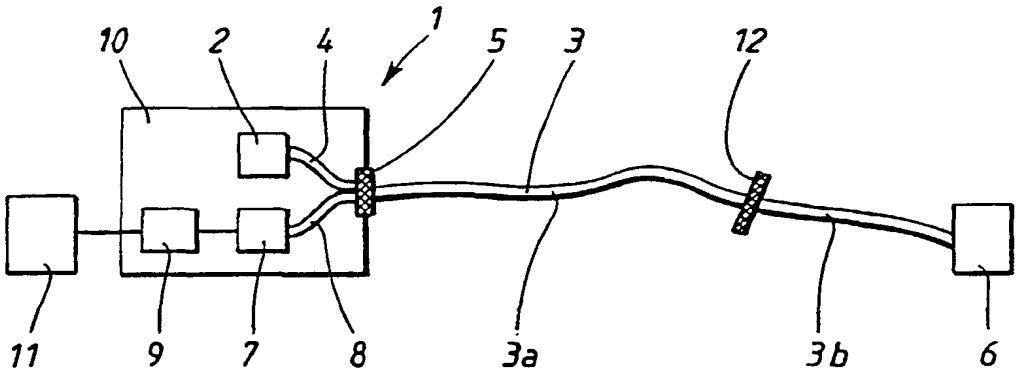
(54) Title: METHOD AND DEVICE FOR FIBRE-OPTICAL MEASURING SYSTEMS



(57) Abstract: The invention relates to a method for optical measuring systems, comprising a sensor element (6) connected to a measuring and control unit (10) via an optical connection (3), and being adapted for providing a signal defining a measurement of a physical parameter (p) influencing the sensor element (6), said method comprising generation of a measuring signal that is brought to come in towards the sensor element (6), and detection of the intensity of the measuring signal (B) in the measuring and control unit (10), after influencing the measuring signal in the sensor element (6). The invention is characterised by comprising partial reflection of the measuring signal at a point along the optical connection (3), at a predetermined distance from the sensor element (6), detection of the intensity of the signal (A), corresponding to said partially reflected measuring signal, and determination of a measurement of said parameter (p) based upon the intensity of the partially reflected signal (A) and the intensity of the measuring signal (B). The invention also relates to a device for carrying out said method. Through the invention, measurements with an optical pressure measuring system are allowed, which exhibit effective compensation for any existing sources for error.

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TITLE:

METHOD AND DEVICE FOR FIBRE-OPTICAL MEASURING SYSTEMS

TECHNICAL FIELD

The present invention relates to a method for measuring systems according to the preamble of the appended claim 1. The invention is especially intended for use with intensity-based fibre-optical measuring systems for pressure measurements. The invention also relates to a device for carrying out such a method, according to the preamble of the appended claim 10.

BACKGROUND ART

In connection with measuring physical parameters such as pressure and temperature, it is previously known to utilise various sensor systems by which the optical intensity of a ray of light, conveyed through an optical fibre and coming in towards a sensor element, is influenced due to changes in the respective physical parameter. Such a system may for example be used when measuring the blood pressure in the veins of the human body. Said system is based upon a transformation from pressure to a mechanical movement, which in turn is transformed into an optical intensity, conveyed by an optical fibre, which is in turn transformed into an electrical signal that is related to the measured pressure.

According to known art, such a fibre-optical measurement system may comprise a pressure sensor, an optical fibre connected to said pressure sensor, and at least one light source and at least one light detector located at the opposite end of the fibre, in order to provide the pressure sensor with light, and to detect the information-carrying light signal returning from the pressure sensor, respectively.

One problem occurring with previously known systems of the above kind relates to the fact that the detected signal will be influenced by various interference factors in connection with the measuring system. For example, the signal may be influenced by any bending of the optical fibre, and by temperature changes and ageing of the optical fibre or of said light source. Also factors such as fibre couplings and fibre connectors in the measuring system in question may influence the information-

carrying signal (for example through influencing its intensity in an unwanted manner) and thus also the final measuring result.

As a result of the above problems there is a need for devices and methods arranged for compensation of any existing sources of error and interference in connection with optical measurements of for example pressure.

There are several previously known measuring systems in which a measuring signal is used together with a separate reference signal. A certain measuring system category is based upon conveying light through two different optical fibres, and is used for said purpose. One example of such a system is shown in the patent document US 5,657,405, which describes a fibre-optical measuring system used for measuring of e.g. pressure. In this system, the interference occurring between two optical conduits through which two corresponding laser light signals are directed towards a membrane, is utilised. One of these light signals is hereby used as a reference signal.

Another previously known category of systems is based on generating and utilising light of two different wavelengths, whereby a reference signal may be obtained. Systems of this kind are previously known from for example the patent documents US 5,280,173 and US 4,933,545.

One disadvantage with the systems according to the two categories mentioned above is that they are relatively complex in their structure. They further require a relatively large number of critical components in the form of LED:s, optical fibres, etc.

DISCLOSURE OF INVENTION

A primary object of the present invention is to provide an improved measuring system, with the aid of which unwanted influences from sources of error and interference in intensity-based fibre-optical measuring systems can be minimised. This is achieved by means of a method and a device in accordance with the present invention, the characteristics of which are defined in the accompanying claims 1 and 10, respectively.

The invention is intended for use in optical measurement systems comprising a sensor element connected to a measuring and control unit via an optical connection, and that are adapted for providing a signal corresponding to a measurement of a physical parameter acting upon the sensor element. The invention consists of a method comprising the generation of a measuring signal that is brought to come in towards the sensor element, and the detection of the intensity of the measuring signal in the measuring and control unit, after influencing the measuring signal in the sensor element. The invention is characterised by comprising partial reflection of the measuring signal at a point along the optical connection, at a predetermined distance from the sensor element, detection of the intensity of the signal corresponding to said partially reflected measuring signal, and determination of a measurement of said parameter based on the intensity of the partially reflected signal and the intensity of the measuring signal.

Through the invention a substantial advantage is achieved, as it can be utilised in a simple and effective manner for compensation of sources of error and interference by intensity-based optical measurements of e.g. pressure.

It is a further object of the invention to provide a method for an optical measuring system, wherein a signal is brought to come in towards a sensor element, and wherein a measurement of the length of an optical connection between said sensor element and a measuring and control unit can be determined in a simple and efficient manner. This measurement can in turn be used to obtain improved measurements. This object is achieved by means of a method, the characteristics of which are defined in the accompanying claim 8.

Said method is based especially upon a determination of a measurement of the length of said optical connection, based on a measured period of time passing from the generation of said signal and up to the detection of said signal. With such a method, the length determination may be used for identification of which sensor element that is currently being connected to the subject measuring and control unit. Hereby, the length of the optical connection is chosen so as to correspond to a specific type of sensor element.

Advantageous embodiments of the invention are defined by the subsequent dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

The invention will be explained in more detail below, with reference to a preferred embodiment and to the enclosed drawings, in which:

Fig. 1 shows, schematically, a measuring system according to the present invention;

Fig. 1a shows an enlarged view of a sensor element suitable for use in connection with the invention; and

Fig. 2 shows a graph illustrating how light signals are detected according to the invention.

PREFERRED EMBODIMENTS

Fig. 1 shows, schematically and somewhat simplified, an intensity-based fibre-optical measuring system 1 according to the present invention. According to a preferred embodiment, the measuring system is designed for pressure measurements, but alternatively, the invention could be used e.g. for measuring temperature or acceleration.

To the measuring system 1 belongs a light source in the form of an LED 2 functioning to emit a light signal of a predetermined wavelength λ_1. The LED 2 is connected to an optical connection, preferably in the form of an as such previously known optical fibre 3, by means of a first link 4 and a fibre coupling 5. The optical fibre 3 is in turn connected to a sensor element 6.

According to what is shown in detail by Fig. 1a, which is an enlarged view of the sensor element 6, said element comprises a cavity 6a, for example obtainable (according to known art) through construction by means of molecular layers (primarily silicone, alternatively silicone dioxide or a combination of the two) and an etching procedure. Preferably, a bonding procedure is also utilised in assembling the various layers of the sensor element 6. The manufacture of such a sensor element 6 is as such previously known, e.g. from the Patent Document PCT/SE93/00393. In this

way, a membrane 6b is also created within the sensor element 6, the deflection of which membrane will depend on the pressure p influencing the sensor element 6.

According to what will be described in detail below, the above light signal will be brought to come in towards the pressure sensor 6, i.e. towards its cavity 6a. Hereby, the pressure p acting on the membrane 6b will modulate the light signal. When the membrane 6b is influenced by a certain pressure p, the dimensions of the cavity 6a, primarily its depth d, will change, entailing a modulation of the light signal through optical interference inside the cavity 6a.

When designing the sensor element 6, the depth d of the cavity 6a is selected to be a value of substantially the same magnitude as the wavelength λ_1 of the light signal. The sizing of the cavity 6a is further made considering the required application area for the sensor element 6, in the current case primarily the pressure range to which the sensor element 6 is to be adapted.

According to the invention, the light signal consists of a pulse of relatively short duration. In normal applications, using an optical fibre 3 with a length of about 2-10 m, the pulse duration is in the order of 10-50 ns. However, the invention is not so limited, but could also be realised with a pulse length deviating from this interval. For example, pulses of longer duration are used in those cases where very long optical fibres (e.g. 100-200 m) are used.

The light pulse thus defines a measuring signal that is transmitted through the fibre 3 and fed into the sensor element 6. The light pulse will be modulated in the manner described above by means of the cavity 6a and is thereby provided with information corresponding to the current pressure p. The light signal modulated by the sensor element 6 is then transmitted back through the fibre 3 and conveyed to a light-sensitive detector 7, through said fibre coupling 5 and a further fibre link 8. The detector 7 is functioning to detect, in a known manner, the intensity of the reflected measuring signal.

For processing of the light signal detected by the detector 7, the measuring system according to the invention also comprises an evaluation unit 9. The evaluation unit 9

thus defines, together with the LED 2, the links 4, 8, the coupling 5 and the detector 7, a measuring and control unit 10, which in turn is connected to a presentation unit 11, e.g. in the form of a display, by the aid of which a measurement of the current pressure p can be visualised for a user.

The two links 4, 8 preferably consist of optical fibres of an as such known kind, the fibre coupling 5 thereby comprising an as such known fibre junction device designed so as to transfer the two fibre links 4, 8 into the fibre 3 leading to the sensor element 6.

It is a basic principle behind the invention that a semi-reflecting device 12 is provided along the optical fibre 3, at a predetermined distance from the sensor element 6. This device 12, according to the embodiment, consists of a so-called ferrule, i.e. a separate, tube-like unit for interconnection of optical fibres, arranged in such a manner that the light pulse emitted from the LED 2 will be partially reflected back to the detector 7, i.e. without having run up to and being influenced by the sensor element 6. The optical connection 3, according to the embodiment, is thus in practice comprised of a first optical conductor 3a that is coupled to a second optical conductor 3b via said ferrule 12. Between the two optical conductors 3a, 3b, a small air gap is hereby provided by means of the ferrule, at which gap said partial reflection will occur.

The invention is not limited to the reflecting device 12 described above. Alternatively, other forms of mirrors, or reflecting coatings and surfaces, may be used to provide a partially reflecting device creating the described light reflection.

Out of the light pulse emitted by the LED 2, two returning light pulses are thus created, i.e. a measuring signal that reaches the sensor element 6 and is then returned, and a reference signal that is returned directly at the reflecting device 12.

The returning light signals will run, via the fibre coupling 5, into the second fibre link 8 and to the detector 7. The detector 7 will hereby detect the intensity of the measuring signal and the reference signal, respectively. Because the reflecting device 12 is arranged at a predetermined distance from the sensor element 6, the reference

signal will reach the light detector 7 a short time period before the measuring signal, reflected at the sensor element 6, will reach the light detector 7. The time period elapsing between the detection of the two signals will hereby depend on the position along the optical fibre 3 at which the reflecting device 12 is arranged, i.e. said period of time will depend on the distance between the reflecting device 12 and the sensor element 6.

With reference to Fig. 2, there is shown, schematically, how two pulses generated in the above manner are detected by means of the detector 7. Fig. 2 thus illustrates the intensity I of the detected pulses, as a function of time t. From the figure it can be gathered that a first pulse A, resulting from the above light signal being reflected against the reflecting device 12, reaches the detector 7, said detector 7 hereby being adapted to determine a value of the intensity I_A of said pulse A. Furthermore, a second pulse B is coming in towards the detector 7 a certain period of time t_1 after the first pulse A having reached the detector 7. The intensity I_B of the second pulse B is also detected by the detector 7. The second pulse B hereby corresponds to the above measuring signal, i.e. a light signal having been modulated in the sensor element 6 and thus containing information regarding the pressure p acting on the sensor element 6 (compare Fig. 1a).

Furthermore, the evaluation unit 9 is adapted to calculate the quotient of the two intensity values of the respective pulses, that is I_A/I_B. Through the invention, a measurement is thus obtained, where the measuring signal (i.e. the second pulse B) defines a measurement of the pressure p, including the effects of any sources of error, and where the reference signal (i.e. the first pulse A) only corresponds to the effects of any sources of error. Through calculating said quotient, a measurement of the current pressure is obtained, where factors reflecting sources of error and interference have thus been compensated for. This is of course an advantage, as it will lead to less interference-sensitive measurements. As examples of unwanted sources of error, any bending of the optical fibre, temperature changes and ageing of the optical fibre or the LED 2, may be mentioned, as well as any changes occurring in the fibre coupling 5.

In essence, it applies that the first pulse A defines a reference signal that can be used to compensate for the effects of any interference in connection with measurements with the measuring system according to the invention.

In order to be able to separate the two pulses A and B during detection in the detector 7, it is required that the period of time t_1 exceeds a minimum limit value. This limit value is depending on how high a resolution that can be achieved with the aid of the measuring and control unit 10. For normal applications, this limit value t_1 is in the order of 10 ns. For normal applications, with optical fibres of the length 2-10 m, it is therefore suitable that the reflecting device 12 is located at about half the distance between the measuring and control unit 10 and the sensor element 6.

According to a variant of the invention (not shown in the figures), the latter can be arranged so as to send one single pulse to two or more branches, in turn comprising two or more optical fibres with a corresponding number of sensor elements. Along each one of the optical fibres, a reflecting device of the above kind will then be provided. By means of suitable location of the respective reflecting devices along each optical fibre, reference signals and measuring signals from each branch can be obtained and detected at predetermined intervals. In this connection, the length of each optical fibre and the location of each individual mirror device must be adapted in such a way that all measuring and reference signals can be individually separated. These signals can then be detected and evaluated in a manner analogous with the above description.

With the aim of providing an especially efficient pressure measurement, the invention could be used for detection of the periods of time elapsing from the generation of a certain light pulse at the LED 2 until it is detected in the detector 7. By means of measured values of such periods of time (and with knowledge of the propagation velocity of the light pulses along the optical connection 3 in question) a measurement of the length of the optical connection between the measuring and control unit 10 and the reflecting device 12, and between the measuring and control unit 10 and the sensor element 6, respectively, can be calculated. If the individual sensor element 6 is fitted to an optical connection given a predetermined, unique length, this type of detection can be utilised for carrying out an identity check of the individual

sensor element. For example, a measured length of the optical connection of 2 m could hereby be said to correspond to a first type of sensor element, whereas a measured length of the optical connection of 3 m could correspond to a second type of sensor element. In this way, the invention could be used in such a manner that the measuring and control unit 10, by detecting the length of a certain optical connection, first identifies what type of sensor element is currently connected. Subsequently, the measuring and control unit 10 may, during the continued measurements, utilise for example information regarding calibration and other similar data, specifically relating to the currently connected sensor element. This type of information would hereby preferably be pre-stored in the measuring and control unit 10 and be used for the individual sensor elements that a specific measuring and control unit 10 is intended to be used with. Through introducing, for example, data regarding the calibration of a specific sensor element to be introduced into the measurements, the invention thus allows improved measurements.

The invention is not limited to the embodiment described above, but may be varied within the scope of the appended claims. For example, the principle behind the invention could be used also for systems not intended for pressure measurements.

Instead of a calculation of the quotient of two intensity values of two light signals, i.e. I_A/I_B (according to the description above), a calculation of the difference (I_A-I_B) between said two values could be performed in the measuring and control unit. Also in this case, a compensation for any sources of error and interference is obtained. According to a further conceivable solution, the two light signals I_A, I_B could be comprised as input parameters in an appropriately formed function, by the aid of which a compensation for sources of error would be provided.

CLAIMS

1. A method for optical measuring systems, comprising a sensor element (6) connected to a measuring and control unit (10) via an optical connection (3) and being adapted for providing a signal corresponding to a measurement of a physical parameter (p) influencing the sensor element (6), said method comprising

generation of a measuring signal that is brought to come in towards the sensor element (6), and

detection of said measuring signal (B) in the measuring and control unit (10), after influencing the measuring signal in the sensor element (6),

characterised by the method further comprising:

partial reflection of the measuring signal at a point along the optical connection (3), located at a predetermined distance from the sensor element (6),

detection of the intensity of the signal (A) corresponding to said partially reflected measuring signal, and

determination of a measurement of said parameter (p) based upon the intensity of the partially reflected signal (A) and the intensity of the measuring signal (B).

2. The method according to claim 1, characterised by comprising:

determination of a value corresponding to the quotient of the intensity (I_A) of said reflected signal (A) and the intensity (I_B) of said measuring signal (B), and

determination of a measurement of said parameter (p) based upon said quotient (I_A/I_B).

3. The method according to claim 1, characterised by comprising:

determination of a value corresponding to the difference between the intensity (I_A) of said reflected signal (A) and the intensity (I_B) of said measuring signal (B), and

determination of a measurement of said parameter (p) based upon said difference (I_A-I_B).

4. A method according to any one of the preceding claims, characterised by said measuring signal (B) being a light pulse.

5. A method according to any one of the preceding claims, characterised by the feeding of the measuring signal into the sensor element (6) causing optical interference in a cavity (6a) of the sensor element (6).

6. A method according to any one of the preceding claims, characterised by being used for measuring pressure (p), said sensor element (6) defining a membrane (6b), acted upon by the pressure (p) surrounding the sensor element (6).

7. A method according to any one of the preceding claims, characterised by being used for measuring the acceleration or the temperature of said sensor element (6).

8. A method for optical measuring systems, comprising a sensor element (6) connected to a measuring and control unit (10) via an optical connection (3) and being adapted for providing a signal corresponding to a measurement of a physical parameter (p) influencing the sensor element (6), said method comprising

generation of a signal which is brought to come in towards the sensor element (6), and

detection of said signal in said measuring and control unit (10) after influencing the measuring signal in said sensor element (6),

characterised by the method further comprising determination of a measurement of the length of said optical connection (3), based upon a measured period of time elapsing from the generation of said signal until the detection of said signal.

9. The method according to claim 8, characterised by said length determination being used for identification of the current type of sensor element (6), said length of said optical connection (3) being selected to correspond to a specific type of sensor element (6).

10. A device for optical measuring systems, comprising a sensor element (6) connected to a measuring and control unit (10) via an optical connection (3) and being adapted for providing a signal corresponding to a measurement of a physical parameter (p) influencing the sensor element (6), said device further comprising a light source (2) functioning to generate a measuring signal brought to come in towards the sensor element (6), and a detector (7) for detecting the intensity of the measuring signal (B) in the measuring and control unit (10), after influencing the measuring signal in the sensor element (6),

characterised by comprising a semi-reflecting device (12) for partial reflection of the measuring signal at a point along the optical connection (3) at a predetermined distance from the sensor element (6), said detector (7) being arranged for detection of the intensity of the signal (A) corresponding to said partially reflected measuring signal, and by comprising an evaluation unit (9) for determining a measurement of said parameter (p), based upon the intensity of the partially reflected signal (A) and the intensity of the measuring signal (B).

11. The device according to claim 10, characterised by said sensor element (6) comprising a cavity (6a), shaped so as to create optical interference when feeding said measuring signal into the cavity (6a).

12. The device according to claim 9, characterised by said cavity (6a) being obtained through building up molecular silicone and/or silicone dioxide layers, and an etching procedure.

13. The device according to claim 12, characterised by said cavity (6a) being obtained through utilising a bonding procedure.

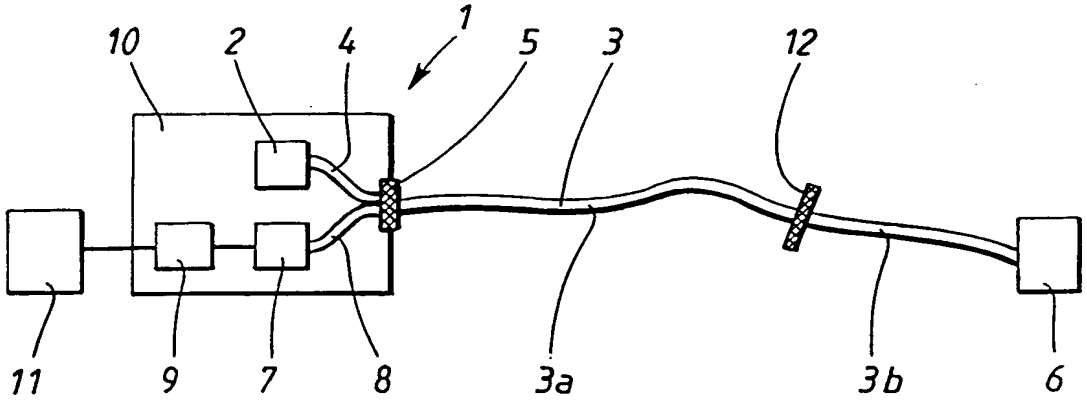

FIG.1

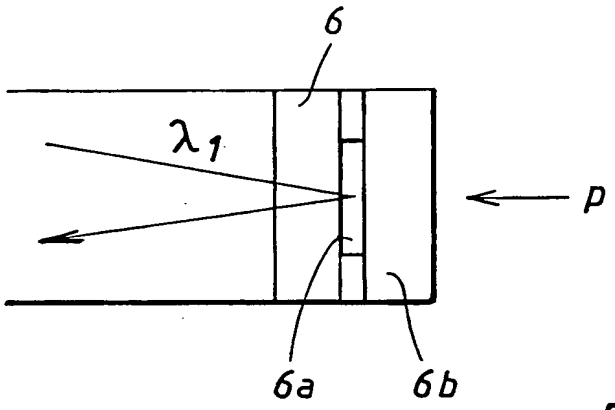

FIG.1a

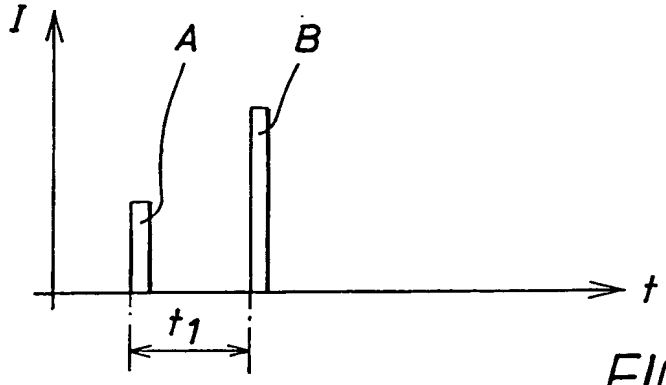

FIG.2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/01404

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G01L 11/02, G01D 5/26, G01B 11/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01L, G01D, G01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5012809 A (J.E.SHULZE), 7 May 1991 (07.05.91), see the whole document	1-7,10-13
Y	US 5051578 A (C.S.SLEMON ET AL), 24 Sept 1991 (24.09.91), see the whole document	1-7,10-13
X	US 5610393 A (C. KLIMCAK ET AL), 11 March 1997 (11.03.97), column 8, line 63 - column 9, line 15	8,9
X	EP 0457941 A1 (KABUSHIKI KAISHA TOSHIBA), 27 November 1991 (27.11.91), column 4, line 27 - line 36	8,9

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
24 November 2000	01 -12- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Lars Jakobsson/LR Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/01404

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4421979 A (C. ASAWA ET AL), 20 December 1983 (20.12.83), abstract ---	8,9
A	EP 0405752 A2 (IMPERIAL CHEMICAL INDUSTRIES PLC), 2 January 1991 (02.01.91), abstract ---	8,9
A	EP 0514747 A2 (SIP SOCIETA ITALIANA PER I'ESERCIZIO DELLE TELECOMUNICAZIONI P.A.), 25 November 1992 (25.11.92), abstract --- --------	8,9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE00/01404

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The claims include two different inventions without common technical features. Unity of invention is therefore lacking according to PCT Rule 13.1.
I. Claims 1-7 and 10-13 relates to an optical measuring system with features to correct a measurement signal.
II. Claims 8-9 relates to a method for measuring length in an optical measuring system.

Invention I and II have no technical features in common.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims: it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/11/00

International application No.
PCT/SE 00/01404

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5012809 A	07/05/91	NONE	
US 5051578 A	24/09/91	US 5191208 A	02/03/93
US 5610393 A	11/03/97	NONE	
EP 0457941 A1	27/11/91	US 5028146 A	02/07/91
US 4421979 A	20/12/83	CA 1183366 A	05/03/85
		EP 0086231 A	24/08/83
		WO 8300744 A	03/03/83
EP 0405752 A2	02/01/91	CA 2017557 A	26/11/90
		DE 69006648 D,T	17/11/94
		GB 8912219 D	00/00/00
		JP 3094143 A	18/04/91
		US 5185521 A	09/02/93
EP 0514747 A2	25/11/92	CA 2068599 A	15/11/92
		IT 1245543 B	29/09/94
		IT T0910355 D	00/00/00
		JP 6180212 A	28/06/94

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
111933 PA		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/SE00/01404	03-07-2000	06-07-1999
International Patent Classification (IPC) or national classification and IPC7		
G01L 11/02, G01D 5/26, G01B 11/02		
Applicant		
SAMBA SENSORS AB et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
11-01-2001	10-09-2001
Name and mailing address of the IPEA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Telex 17978 PATOREG-S Facsimile No. 08-667 72 88	Lars Jakobsson /itw Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE00/01404

I. Basis of the report

1. With regard to the **elements** of the international application:*

☒ the international application as originally filed

☐ the description:
pages _____ , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

☐ the claims:
pages _____ , as originally filed
pages _____ , as amended (together with any statement) under article 19
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

☐ the drawings:
pages _____ , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

☐ the sequence listing part of the description:
pages _____ , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language english which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☒ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.*

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

   ☐ restricted the claims.

   ☒ paid additional fees.

   ☐ paid additional fees under protest.

   ☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with rules 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:

The claims include two different inventions without common technical features. Unity of invention is therefore lacking according to PCT Rule 13.1.

I. Claims 1-7 and 10-13 relates to an optical measuring system with features to correct a measurement signal.

II. Claims 8-9 relates to a method for measuring length in an optical measuring system.

Invention I and II have no technical features in common.

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

   ☒ all parts.

   ☐ the parts relating to claims Nos. _____

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE00/01404

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-13	YES
	Claims		NO
Inventive step (IS)	Claims		YES
	Claims	1-13	NO
Industrial applicability (IA)	Claims	1-13	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Documents cited in the International Search Report:

US 5012809
US 5051578
US 5610393
EP 0457941
US 4421979
EP 0405752
EP 0514747

US 5012809 describe a method and a device for optical measuring systems. A sensor element (110) is connected to a measuring and control unit via an optical connection and being adapted for providing a signal corresponding to a measurement parameter influencing the sensor element. A measuring signal is partially reflected at a point (142) along the optical connection located at a predetermined distance from the sensor element. The measurement parameter is determined based upon the intensity of the partially reflected signal and the intensity of the measuring signal. Claim 1 and 10 do not differ in any essential way from what is previously known from US 5012809. Therefore, claim 1 and 10 do not involve an inventive step.

From each of US 5610393, EP 0457941 and US 4421979 is a method for optical measuring systems previously known, where a sensor element (16, 22-23, resp 14) is connected to a measuring and control unit via an optical connection. The sensor element being adapted for providing a signal corresponding to a measurement of a parameter influencing the sensor element. A signal is generated and is brought to come in towards the sensor element.

... / ...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V

The signal influenced by the sensor element is detected. The arrival time of the detected signal is also registered and is an indication of the position of the sensor element. See US 5610393, column 8, line 63 - column 9, line 15, EP 0457941 column 4, line 27 - line 36 and US 4421979 abstract and figure 7,"time or distance along fiber". The arrival time corresponds to the length of said optical connection to the sensor element. Claim 8 does not involve an inventive step.

US 5610393 and US 4421979 also describe a plurality of sensor elements. It must be obvious for a person skilled in the art to use different types of sensor elements and where the length determination is an identification of the specific type of sensor element. Therefore, claim 9 do not involve an inventive step.

In view of the cited documents, remaining claims are matters of fact, which are previously known from the cited documents or are obvious to a person skilled in the art.

The claimed invention is novel (N) but does not fulfil the requirement of inventive step (IS). The claimed invention is industrially applicable.

RECORD COPY

REQUEST

The undersigned request that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/SE 00 / 01404

International Filing Date 03 -07- 2000

The Swedish Patent Office
PCT International Application

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference 111933 PA
(if desired) (12 characters maximum)

Box No. I TITLE OF INVENTION

Method and device for measuring system

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)*

Samba Sensors AB
Första Långgatan 26
SE-413 28 GÖTEBORG
Sweden

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State *(that is, country)* of nationality: SE

State *(that is, country)* of residence: SE

This person is the applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)*

HÖJER Svante
Fredkullagatan 21
SE-442 35 KUNGÄLV
Sweden

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: SE

State *(that is, country)* of residence: SE

This person is the applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: [X] agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

ANDERSSON Per, BERGQUIST Gunnar, BRUN Jonny, GRAUDUMS Valdis, HARRISON Michael, MOSSMARK Anders, OLSSON Stefan, ROMARE Anette, ROSANDER Bengt, SCHLOSSMAN Ulf, SÖRSDAHL Petter
ALBIHNS PATENTBYRÅ GÖTEBORG AB,
P.O. Box 142,
S-401 22 GÖTEBORG, Sweden

Telephone No.
+46 31 725 81 00

Facsimile No.
+46 31 711 95 55

Teleprinter No.

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

PCT/ SE 00 / 0 1 4 0 4

03 -07- 2000

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet is not to be included in the request.

Name and address: *Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)*

JOSEFSSON Thorleif
Älgstigen 24 B
SE-433 50 PARTILLE
Sweden

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(i.e. country)* of nationality: SE

State *(i.e. country)* of residence: SE

This person is the applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)*

KRANZ Martin
Berglärkan 29
SE-426 69 VÄSTRA FRÖLUNDA
Sweden

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(i.e. country)* of nationality: SE

State *(i.e. country)* of residence: SE

This person is the applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)*

VIDOVIC Nevio
Ekvägen 1
SE-428 37 KÅLLERED
Sweden

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(i.e. country)* of nationality: SE

State *(i.e. country)* of residence: SE

This person is the applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(i.e. country)* of nationality:

State *(i.e. country)* of residence:

This person is the applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

☐ **AP** **ARIPO Patent:** **GH** Ghana, **GM** Gambia, **KE** Kenya, **LS** Lesotho, **MW** Malawi, **SD** Sudan, **SL** Sierra Leone **SZ** Swaziland, **UG** Uganda, **ZW** Zimbabwe, and any other State which is a Contracting state of the Harare Protocol and of the PCT

☐ **EA** **Eurasian Patent:** **AM** Armenia, **AZ** Azerbaijan, **BY** Belarus, **KG** Kyrgyzstan, **KZ** Kazakstan, **MD** Republic of Moldova, **RU** Russian Federation, **TJ** Tajikistan, **TM** Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT

☒ **EP** **European Patent:** **AT** Austria, **BE** Belgium, **CH and LI** Switzerland and Liechtenstein, **CY** Cyprus, **DE** Germany, **DK** Denmark, **ES** Spain, **FI**, Finland, **FR** France, **GB** United Kingdom, **GR** Greece, **IE** Ireland, **IT** Italy, **LU** Luxembourg, **MC** Monaco, **NL** Netherlands, **PT** Portugal, **SE** Sweden, and any other State which is Contracting State of the European Patent Convention and of the PCT

☐ **OA** **OAPI Patent:** **BF** Burkina Faso, **BJ** Benin, **CF** Central African Republic, **CG** Congo, **CI** Côte d'Ivoire, **CM** Cameroon, **GA** Gabon, **GN** Guinea, **GW** Guinea-Bissau, **ML** Mali, **MR** Mauritania, **NE** Niger, **SN** Senegal, **TD** Chad, **TG** Togo, and any other State which is member State of OAPI and a Contracting State of the PCT (*if other kind of protection or treatment desired, specify on dotted line*).....

National Patent (*if other kind of protection or treatment desired, specify on dotted line*):

☐ **AG** Antiqua and Barbuda
☐ **AM** Armenia.....
☐ **AT** Austria.....
☐ **AU** Australia.....
☐ **AZ** Azerbaijan
☐ **BA** Bosnia and Herzegovina.....
☐ **BB** Barbados
☐ **BG** Bulgaria.....
☐ **BR** Brazil.....
☐ **BY** Belarus.....
☐ **CA** Canada
☐ **CH and LI** Switzerland and Liechtenstein
☐ **CN** China.....
☐ **CU** Cuba.....
☐ **CZ** Czech Republic.....
☐ **DE** Germany.....
☐ **DK** Denmark.....
☐ **DZ** Algeria
☐ **EE** Estonia.....
☐ **ES** Spain.....
☐ **FI** Finland.....
☐ **GB** United Kingdom
☐ **GD** Grenada.....
☐ **GE** Georgia.....
☐ **GH** Ghana.....
☐ **GM** Gambia
☐ **HR** Croatia
☐ **HU** Hungary.....
☐ **ID** Indonesia
☐ **IL** Israel.....
☐ **IN** India
☐ **IS** Iceland
☒ **JP** Japan.....
☐ **KE** Kenya.....
☐ **KG** Kyrgyzstan.....
☐ **KP** Demoratic People's Republic of Korea.....
☐ **KR** Republic of Korea.....
☐ **KZ** Kazakstan.....
☐ **LC** Saint Lucia
☐ **LK** Sri Lanka
☐ **LR** Liberia
☐ **LT** Lithuania
☐ **LU** Luxembourg
☐ **LV** Latvia
☐ **MD** Republic of Moldova.....
☐ **MG** Madagascar.....
☐ **MK** The former Yugoslav Republic of Macedonia.....
☐ **MN** Mongolia
☐ **MW** Malawi.....
☐ **MX** Mexico.....
☐ **NO** Norway
☐ **NZ** New Zealand.....
☐ **PL** Poland.....
☐ **PT** Portugal.....
☐ **RO** Romania
☐ **RU** Russian Federation.....
☐ **SD** Sudan
☐ **SE** Sweden
☐ **SG** Singapore
☐ **SI** Slovenia.....
☐ **SK** Slovakia.....
☐ **SL** Sierra Leone
☐ **TJ** Taijikistan.....
☐ **TM** Turkmenistan.....
☐ **TR** Turkey.....
☐ **TT** Trinidad and Tobago.....
☐ **UA** Ukraine.....
☐ **UG** Uganda.....
☒ **US** United States of America.....
☐ **UZ** Uzbekistan.....
☐ **VN** Viet Nam.....
☐ **YU** Yugoslavia.....
☐ **ZW** Zimbabwe.....

Check boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after:

issuance of this sheet:

☐ **AE** United Arab Emirates .....
☐ **ZA** Sydafrika.....
☐ **LS** Lesotho
☐ **MD** Republic of Moldova
☐ **TZ** United Republic of Tanzania

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is: national application: country:	regional application:* regional Office	international application: receiving Office
item (1) 6 July 1999	9902590-0	SE		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s) : (1)

* *Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(If two or more international Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*
ISA /SE

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*
Date (*day/month/year*): Number Country (*or regional Office*)

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following **number of sheets**:

request:	4 ✓
description (excluding sequence listing part):	11 ✓
claims:	4 ✓
abstract:	1 ✓
drawings:	1 ✓
sequence listing part of description:	
Total number of sheets:	21

This international application is **accompanied by** the item(s) marked below:

1. ☐ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☐ other *(specify):*

Figure of the drawings which should accompany the abstract: Fig. 1

Language of filing of the international application: Swedish

Box No. IX SIGNATURE OR APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).
Göteborg 30 June 2000

Per Andersson

For receiving Office use only

1. Date of actual receipt of the purported international application: 03 -07- 2000
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT-Article 11(2):
5. International Searching Authority (if two or more are competent): ISA/SE
6. ☐ Transmittal of search copy delayed until search fee is paid

2. Drawings: ☒ received: ☐ not received:

For International Bureau use only

Date of receipt of the record copy by the International Bureau: 04 [illegible] (04.07.00)

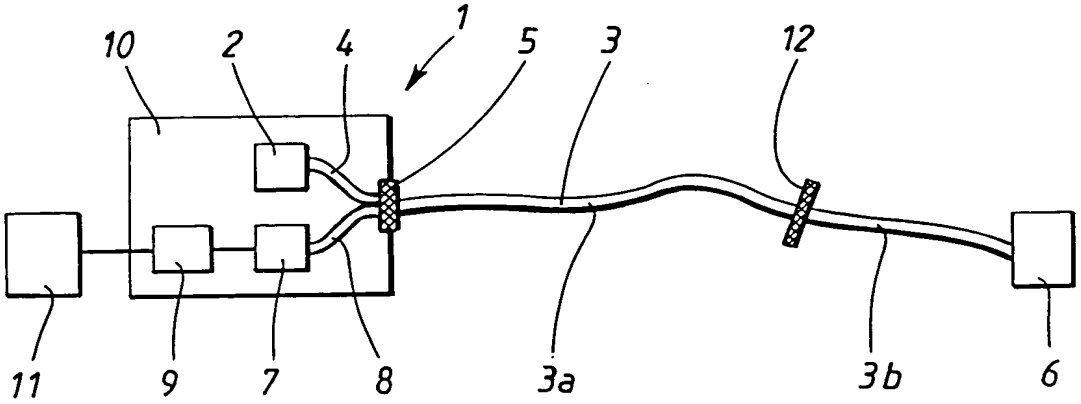

FIG.1

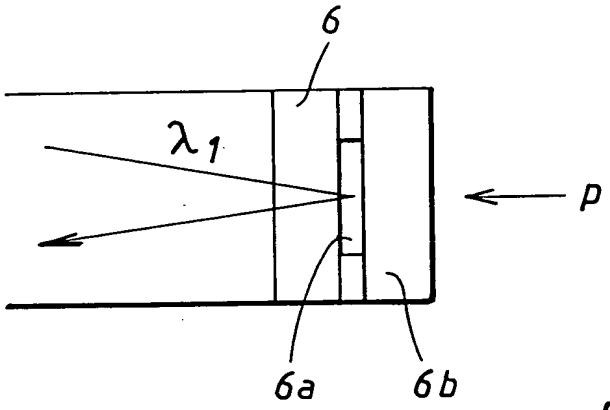

FIG.1a

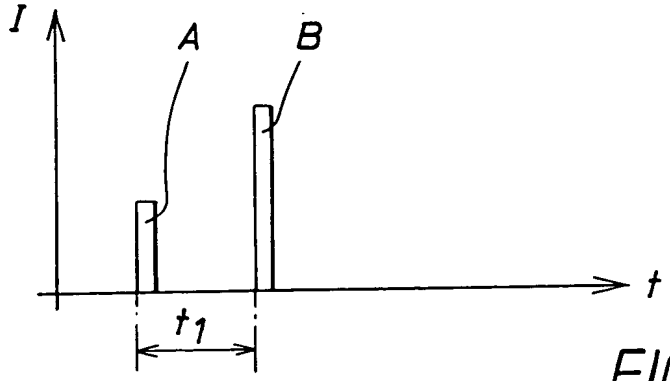

FIG.2

TITEL:
Förfarande och anordning vid mätsystem.

TEKNISKT OMRÅDE:
Föreliggande uppfinning avser ett förfarande vid mätsystem, enligt ingressen till det efterföljande patentkravet 1. Uppfinningen är i synnerhet avsedd att utnyttjas vid intensitetsbaserade fiberoptiska mätsystem för tryckmätning. Uppfinningen avser även en anordning för genomförande av ett sådant förfarande, enligt ingressen till det efterföljande patentkravet 10.

TEKNIKENS STÅNDPUNKT:
I samband med mätning av fysikaliska storheter som exempelvis tryck och temperatur är det tidigare känt att utnyttja olika sensorsystem vid vilka den optiska intensiteten hos en ljusstråle som leds genom en optisk fiber och infaller mot ett sensorelement påverkas till följd av förändringar hos den aktuella fysikaliska storheten. Exempelvis kan ett sådant system användas vid mätning av blodtryck i ådror i människokroppen. Nämnda system baseras då på omvandling från tryck till en mekanisk rörelse, vilken i sin tur omvandlas till en av en optisk fiber transporterad ljussignal med viss optisk intensitet. Denna signal omvandlas i sin tur till en elektrisk signal som svarar mot det uppmätta trycket.

Enligt känd teknik kan ett sådant fiberoptiskt mätsystem innefatta en trycksensor, en till trycksensorn ansluten optisk fiber samt minst en ljuskälla och minst en ljusdetektor placerade i motsatt ände av fibern för att förse trycksensorn med ljus respektive för att detektera en från trycksensorn återkommande informationsbärande ljussignal.

Ett problem som uppstår vid tidigare kända system av

ovannämnt slag hänför sig till det faktum att den detekterade signalen kommer att påverkas av olika störningar i anslutning till mätsystemet. Exempelvis kan signalen påverkas av eventuell böjning av den optiska fibern samt genom temperaturförändringar och åldring hos den optiska fibern eller hos nämnda ljuskälla. Även faktorer som fiberkopplingar och fiberkontakter i det aktuella mätsystemet kan påverka den informationsbärande signalen (exempelvis genom att dess intensitet påverkas på ett icke önskvärt sätt) och således också det slutgiltiga mätresultatet.

På grund av ovanstående problemställning finns det ett behov av anordningar och metoder som är inrättade att kompensera för eventuellt förekommande felkällor och störningar i samband med optiska mätningar av exempelvis tryck.

Det finns förut känt ett flertal mätsystem vid vilka en mätsignal utnyttjas tillsammans med en särskild referenssignal. En viss kategori av mätsystem baseras på att ljus leds genom två olika optiska fibrer och används för nämnda ändamål. Ett exempel på ett sådant system visas i patentdokumentet US 5657405, vilket visar ett fiberoptiskt mätsystem som utnyttjas för mätning av exempelvis tryck. Vid detta system utnyttjas interferens som uppstår mellan två optiska kanaler genom vilka två motsvarande laserljussignaler matas mot ett membran. En av dessa ljussignaler utnyttjas då som referenssignal.

En annan förut känd kategori av system baseras på att ljus av två olika våglängder genereras och utnyttjas, varigenom en referenssignal kan erhållas. System av detta slag är förut kända genom exempelvis patentdokumenten US 5280173 och US 4933545.

En nackdel med systemen enligt de två ovannämnda kategorierna är att de är relativt komplexa till sin uppbyggnad. Dessutom kräver de ett relativt stort antal kritiska komponenter i form av lysdioder, optiska fibrer etc.

REDOGÖRELSE FÖR UPPFINNINGEN:

Ett huvudsakligt ändamål med föreliggande uppfinning är att tillhandahålla ett förbättrat mätsystem med vars hjälp oönskad påverkan av felkällor och störningar vid intensitetsbaserade fiberoptiska mätsystem kan minimeras. Detta uppnås medelst ett förfarande och en anordning i enlighet med föreliggande uppfinning, vars särdrag framgår av efterföljande patentkrav 1 respektive 10.

Uppfinningen är avsedd att utnyttjas vid optiska mätsystem som innefattar ett sensorelement som är anslutet till en mät- och styrenhet via en optisk förbindelse och som är inrättat att avge en signal som utgör ett mått på en fysikalisk parameter som påverkar sensorelementet. Uppfinningen utgör ett förfarande som innefattar generering av en mätsignal som bringas att infalla mot sensorelementet, samt detektering av intensiteten hos mätsignalen i mät- och styrenheten efter påverkan av mätsignalen i sensorelementet. Uppfinningen kännetecknas av att den innefattar partiell reflektion av mätsignalen i en punkt längs den optiska förbindelsen på förutbestämt avstånd till sensorelementet, detektering av intensiteten hos den signal som svarar mot nämnda partiellt reflekterade mätsignal, samt bestämning av ett mått på nämnda parameter med utgångspunkt från intensiteten hos den partiellt reflekterade signalen och intensiteten hos mätsignalen.

Genom uppfinningen fås en väsentlig fördel genom att den på ett enkelt och effektivt sätt kan utnyttjas för kompensation av felkällor och störningar vid

intensitetsbaserade optiska mätningar av exempelvis tryck.

Det är ett ytterligare syfte med uppfinningen att tillhandahålla ett förfarande vid ett optiskt mätsystem vid vilket en signal fås att infalla mot ett sensorelement, och vid vilket ett mått på längden hos en optisk förbindelse mellan nämnda sensorelement och en mät- och styrenhet kan bestämmas på ett enkelt och effektivt sätt. Detta mått kan i sin tur utnyttjas för att erhålla en förbättrad mätning. Detta syfte uppnås medelst ett förfarande vars särdrag framgår av efterföljande patentkrav 8.

I synnerhet baseras nämnda förfarande på en bestämning av ett mått på längden hos nämnda optiska förbindelse med utgångspunkt från en uppmätt tidsperiod som förflyter från genereringen av nämnda signal och fram till en detektering av nämnda signal. Vid ett sådant förfarande kan längdbestämningen utnyttjas för identifiering av vilket sensorelement som för tillfället är förbundet med den aktuella mät- och styrenheten. Härvid väljs längden hos den optiska förbindelse så att den motsvarar en specifik typ av sensorelement.

Fördelaktiga utföringsformer av uppfinningen framgår av de efterföljande beroende patentkraven.

FIGURBESKRIVNING:
Uppfinningen kommer i det följande att förklaras närmare med hänvisning till ett föredraget utföringsexempel och de bifogade ritningarna, där:

figur 1 schematiskt visar ett mätsystem i enlighet med den föreliggande uppfinningen,

figur 1a visar i förstoring ett sensorelement som är lämpligt att utnyttjas i samband med uppfinningen, samt

figur 2 är ett diagram som visar hur ljussignaler detekteras i enlighet med uppfinningen.

FÖREDRAGNA UTFÖRINGSFORMER:

I figur 1 visas schematiskt och något förenklat ett intensitetsbaserat fiberoptiskt mätsystem 1 enligt den föreliggande uppfinningen. Enligt en föredragen utföringsform utgörs mätsystemet för mätning av tryck, men uppfinningen kan alternativt utnyttjas exempelvis för mätning av temperatur eller acceleration.

Till mätsystemet 1 hör en ljuskälla i form av en lysdiod 2 som är inrättad att emittera en ljussignal med en förutbestämd våglängd λ_1. Lysdioden 2 är ansluten till en optisk förbindelse, företrädesvis i form av en i sig förut känd optisk fiber 3, via en första länk 4 samt via en fiberkoppling 5. Den optiska fibern 3 är i sin tur förbunden med ett sensorelement 6.

Enligt vad som framgår i detalj av figur 1a, som är en delförstoring av sensorelementet 6, innefattar detta en kavitet 6a, vilken exempelvis kan erhållas (i enlighet med känd teknik) genom uppbyggnad medelst molekylära skikt (främst kisel, alternativt kiseldioxid eller en kombination av kisel och kiseldioxid) och ett etsningsförfarande. Lämpligen utnyttjas också ett bondningsförfarande vid utformningen av sensorelementet 6. Tillverkningen av ett sådant sensorelement 6 är i sig förut känt, exempelvis från patentdokumentet PCT/SE93/00393. På så vis bildas i sensorelementet 6 också ett membran 6b, vars böjning beror av det tryck p som påverkar sensorelementet 6.

Enligt vad som kommer att beskrivas i detalj nedan bringas den ovannämnda ljussignalen att infalla mot sensorelementet

6, d.v.s. mot dess kavitet 6a. Ljussignalen kommer härvid att moduleras av det tryck p som verkar mot membranet 6b. Vid påverkan av membranet 6b med ett visst tryck p kommer således kavitetens 6a dimensioner, främst dess djup d, att förändras, vilket leder till att ljussignalen moduleras genom optisk interferens i kaviteten 6a.

Vid utformningen av sensorelementet 6 väljes kavitetens 6a djup d till ett värde som är av huvudsakligen samma storleksordning som ljussignalens våglängd λ_1. Dimensioneringen av kaviteten 6a sker dessutom under beaktande av önskat användningsområde för sensorelementet 6, i det aktuella fallet främst vilket tryckintervall sensorelementet 6 skall anpassas för.

Enligt uppfinningen utgörs ljussignalen av en puls av relativt kort varaktighet. I normala tillämpningar, varvid en optisk fiber 3 med en längd på c:a 2-10 m utnyttjas, är varaktigheten hos pulsen av storleksordningen 20-50 ns. Uppfinningen är dock inte begränsad till detta, utan kan också realiseras med en pulslängd som avviker från detta intervall. Exempelvis utnyttjas pulser med längre varaktighet i de fall där mycket långa optiska fibrer (t.ex. 100-200 m) utnyttjas.

Ljuspulsen utgör således en mätsignal som transmitteras genom fibern 3 och leds in i sensorelementet 6. Ljuspulsen moduleras på ovan nämnt vis med hjälp av kaviteten 6a och ges därigenom information som svarar mot det aktuella trycket p. Den av sensorelementet 6 modulerade ljuspulsen transmitteras därefter tillbaka genom fibern 3 och leds till en ljuskänslig detektor 7, via den ovannämnda fiberkopplingen 5 och en ytterligare fiberlänk 8. Detektorn 7 är på känt sätt inrättad att detektera intensiteten hos den reflekterade mätsignalen.

För behandling av den av detektorn 7 detekterade ljussignalen innefattar mätsystemet enligt uppfinningen en utvärderingsenhet 9. Utvärderingsenheten 9 bildar på så vis tillsammans med lysdioden 2, länkarna 4, 8, kopplingen 5 och detektorn 7 en mät- och styrenhet 10, vilken i sin tur är ansluten till en presentationsenhet 11, exempelvis i form av en display, med vars hjälp ett mått på det aktuella trycket p kan åskådliggöras för en användare.

De två länkarna 4, 8 utgörs företrädesvis av optiska fibrer av i sig känt slag, varvid fiberkopplingen 5 innefattar en i sig känd fiberförgrening som är utformad så att de två fiberlänkarna 4, 8 övergår i den fiber 3 som leder fram till sensorelementet 6.

Det är en grundprincip bakom uppfinningen att en semi-reflekterande anordning 12 finns anordnad längs den optiska fibern 3, på ett förutbestämt avstånd från sensorelementet 6. Denna anordning 12 utgörs enligt utföringsformen av en s.k. ferrul, d.v.s. en särskild rörliknande enhet för sammankoppling av optiska fibrer som är så inrättad att en den från lysdioden 2 utsända ljuspulsen partiellt reflekteras tillbaks till detektorn 7, d.v.s. utan att ha löpt fram till och påverkats av sensorelementet 6. Den optiska förbindelsen 3 enligt utföringsformen utgörs således i själva verket av en första optisk ledare 3a som är sammanfogad med en andra optisk ledare 3b via nämnda ferrul 12. Mellan de två optiska ledarna 3a, 3b anordnas då med hjälp av ferrulen ett litet luftgap, vid vilket nämnda partiella reflektion uppstår.

Uppfinningen är inte begränsad till den reflekterande anordning 12 som beskrivits ovan. Alternativt kan andra former av speglar eller reflekterande beläggningar och ytor utnyttjas för att tillhandahålla en partiellt reflekterande

anordning som ger upphov till den beskrivna ljusreflektionen.

Ur den ljuspuls som genereras av lysdioden 2 uppstår således två returnerade ljuspulser, d.v.s. en mätsignal som når sensorelementet 6 och därefter returneras, samt en referenssignal som returneras direkt vid den reflekterande anordningen 12.

De återgående ljussignalerna går via fiberkopplingen 5 in i den andra fiberlänken 8 och till detektorn 7. Detektorn 7 detekterar då intensiteten hos mätsignalen respektive referenssignalen. På grund av att den reflekterande anordningen 12 är anordnad på ett förutbestämt avstånd från sensorelementet 6 kommer referenssignalen att nå ljusdetektorn 7 en kort tidsperiod innan den vid sensorelementet 6 reflekterade mätsignalen når ljusdetektorn 7. Den tidsperiod som förflyter mellan detekteringen av de båda signalerna kommer därvid att bero på den position längs den optiska fibern 3 vid vilken den reflekterande anordningen 12 finns anordnad, d.v.s. nämnda tidsperiod beror på avståndet mellan den reflekterande anordningen 12 och sensorelementet 6.

Med hänvisning till figur 2 visas schematiskt hur två pulser som genererats på ovannämnda sätt detekteras med hjälp av detektorn 7. Således visas i figur 2 intensiteten I hos de detekterade pulserna som funktion av tiden t. Av figuren framgår att en första puls A som resulterar av att den ovannämnda ljussignalen reflekteras mot den reflekterande anordningen 12 når detektorn 7, varvid detektorn 7 då är inrättad att bestämma ett värde på intensiteten I_A hos denna puls A. Dessutom infaller en andra puls B mot detektorn 7 en viss tidsperiod t_1 efter att den första pulsen A har nått detektorn 7. Intensiteten

I_B hos den andra pulsen B detekteras också av detektorn 7. Den andra pulsen B motsvarar då den ovannämnda mätsignalen, d.v.s. en ljussignal som har modulerats i sensorelementet 6 och som då innehåller information avseende det tryck p som verkar mot sensorelementet 6 (jfr. figur 1a).

Vidare är utvärderingsenheten 9 inrättad att beräkna kvoten mellan de två värdena på intensiteten hos respektive puls, d.v.s. I_A/I_B. Genom uppfinningen erhålles således en mätning där mätsignalen (d.v.s. den andra pulsen B) utgör ett mått på trycket p, inklusive inverkan av eventuella felkällor, och där referenssignalen (d.v.s. den första pulsen A) endast motsvarar inverkan av eventuella felkällor. Genom beräkning av nämnda kvot fås ett mått på det aktuella trycket där faktorer som återspeglar felkällor och störningar då har kompenserats bort. Detta är givetvis en fördel eftersom det leder till mindre störkänsliga mätningar. Som exempel på oönskade felkällor kan nämnas eventuell böjning av den optiska fibern, temperaturförändringar och åldring hos den optiska fibern eller lysdioden 2 samt eventuella förändringar som uppstår hos fiberkopplingen 5.

Sammantaget gäller att den första pulsen A utgör en referenssignal som kan utnyttjas för att kompensera bort inverkan av eventuella störningar i samband med mätning med det uppfinningsenliga mätsystemet.

För att de två pulserna A och B skall kunna särskiljas vid detekteringen i detektorn 7 krävs att tidsperioden t_1 överstiger ett minsta gränsvärde. Detta gränsvärde beror på hur hög upplösning som kan erhållas med hjälp av mät- och styrenheten 10. I normala applikationer är detta gränsvärde t_1 av storleksordningen 10 ns. Vid normala applikationer med optiska fibrer av längden 2-10 m är det därför lämpligt

att den reflekterande anordningen 12 placeras på ungefär halva avståndet mellan mät- och styrenheten 10 och sensorelementet 6.

Enligt en variant av uppfinningen (som ej visas i figurerna) kan denna inrättas så att en enstaka puls skickas till två eller flera grenar som i sin tur innefattar två eller flera optiska fibrer med ett motsvarande antal sensorelement. Längs var och en av de optiska fibrerna finns då anordnat en reflekterande anordning av ovannämnt slag. Genom lämplig placering av respektive reflekterande anordning längs respektive optiska fiber kan referenssignaler och mätsignaler från respektive gren erhållas och detekteras med förutbestämda tidsintervall. I detta sammanhang måste längden hos respektive optiska fiber samt placeringen av respektive spegelanordning anpassas på så vis att samtliga mät- och referenssignaler kan särskiljas individuellt. Dessa signaler kan då detekteras och utvärderas på ett sätt som är analogt med vad som beskrivits ovan.

I syfte att tillhandahålla en särskilt effektiv tryckmätning kan uppfinningen utnyttjas för bestämning av de tidsperioder som förflyter från det att en viss ljuspuls genereras av lysdioden 2 och till det att den detekteras i detektorn 7. Med hjälp av uppmätta värden på dessa tidsperioder (och med vetskap om ljuspulsernas utbredningshastighet längs den aktuella optiska förbindelsen 3) kan ett mått på längden hos den optiska förbindelsen mellan mät- och styrenheten 10 och den reflekterande anordningen 12, respektive mellan mät- och styrenheten 10 och sensorelementet 6, beräknas. Om respektive sensorelement 6 är monterad vid en optisk förbindelse som ges en förutbestämd, unik längd, kan denna typ av detektering utnyttjas för att utföra en identitetskontroll av respektive sensorelement. Exempelvis

kan en uppmätt längd hos den optiska förbindelsen på 2 m då sägas motsvara en första typ av sensorelement, medan en uppmätt längd hos den optiska förbindelsen på 3 m kan motsvara en andra typ av sensorelement. På så vis kan uppfinningen utnyttjas så att mät- och styrenheten 10 genom detektering av längden hos en viss optisk förbindelse först identifierar vilken typ av sensorelement som för tillfället är anslutet. Därefter kan mät- och styrenheten 10 under de fortsatta mätningarna utnyttja exempelvis information avseende kalibrering och andra liknande data som specifikt avser det för tillfället anslutna sensorelementet. Sådan information är företrädesvis på förhand lagrad i mät- och styrenheten 10 och utnyttjas då för de respektive sensorelement som en viss mät- och styrenheten 10 är avsedd att kunna utnyttjas med. Genom att exempelvis data avseende kalibrering hos ett visst sensorelement kan införas i mätningarna möjliggörs således med uppfinningen en förbättrad mätning.

Uppfinningen är inte begränsad till den ovan beskrivna utföringsformen, utan kan varieras inom ramen för de efterföljande patentkraven. Exempelvis kan principen bakom uppfinningen utnyttjas även vid system som inte är avsedda för tryckmätning.

Istället för en beräkning av kvoten mellan två värden på intensiteten hos två ljussignaler, d.v.s. I_A/I_B (enligt vad som beskrivits ovan) kan en beräkning av skillnaden (I_A-I_B) mellan nämnda två värden utföras i mät- och styrenheten. Även i detta fall erhålles då en kompensation av felkällor och störningar. Enligt en ytterligare tänkbar lösning kan de två ljussignalerna I_A, I_B ingå som inparametrar i en lämpligt utformad funktion med vars hjälp en kompensation av felkällor tillhandahålls.

111933 PA
2000-06-29

PATENTKRAV:

1. Förfarande vid optiska mätsystem innefattande ett sensorelement (6) som är anslutet till en mät- och styrenhet (10) via en optisk förbindelse (3) och som är inrättat att avge en signal som utgör ett mått på en fysikalisk parameter (p) som påverkar sensorelementet (6), vilket förfarande innefattar

generering av en mätsignal som bringas att infalla mot sensorelementet (6), samt

detektering av intensiteten hos mätsignalen (B) i mät- och styrenheten (10) efter påverkan av mätsignalen i sensorelementet (6),

k ä n n e t e c k n a t d ä r a v att förfarandet dessutom innefattar:

partiell reflektion av mätsignalen i en punkt längs den optiska förbindelsen (3) på förutbestämt avstånd till sensorelementet (6),

detektering av intensiteten hos den signal (A) som svarar mot nämnda partiellt reflekterade mätsignal, samt

bestämning av ett mått på nämnda parameter (p) med utgångspunkt från intensiteten hos den partiellt reflekterade signalen (A) och intensiteten hos mätsignalen (B).

2. Förfarande enligt patentkrav 1, k ä n n e t e c k n a t d ä r a v , att det innefattar:

bestämning av ett värde som motsvarar kvoten av intensiteten (I_A) hos nämnda reflekterade signal (A) och intensiteten (I_B) hos nämnda mätsignal (B), samt

bestämning av ett mått på nämnda parameter (p) med utgångspunkt från nämnda kvot (I_A/I_B).

3. Förfarande enligt patentkrav 1, k ä n n e t e c k n a t d ä r a v , att det innefattar:

bestämning av ett värde som motsvarar skillnaden mellan intensiteten (I_A) hos nämnda reflekterade signal (A) och intensiteten (I_B) hos nämnda mätsignal (B), samt

bestämning av ett mått på nämnda parameter (p) med utgångspunkt från nämnda skillnadsvärde (I_A-I_B).

4. Förfarande enligt något av föregående patentkrav, k ä n n e t e c k n a t d ä r a v , att nämnda mätsignal (B) utgörs av en ljuspuls.

5. Förfarande enligt något av föregående patentkrav, k ä n n e t e c k n a t d ä r a v , att matningen av mätsignalen till sensorelementet (6) ger upphov till optisk interferens i en till sensorelementet (6) hörande kavitet (6a).

6. Förfarande enligt något av föregående patentkrav, k ä n n e t e c k n a t d ä r a v , att det utnyttjas vid mätning av tryck (p), varvid nämnda sensorelement (6) definierar ett membran (6b) vilket påverkas av det tryck (p) som omger sensorelementet (6).

7. Förfarande enligt något av föregående patentkrav, k ä n n e t e c k n a t d ä r a v , att det utnyttjas vid mätning av acceleration eller temperatur hos nämnda sensorelement (6).

8. Förfarande vid optiska mätsystem innefattande ett sensorelement (6) som är anslutet till en mät- och styrenhet (10) via en optisk förbindelse (3) och som är inrättat att avge en signal som utgör ett mått på en fysikalisk parameter (p) som påverkar sensorelementet (6), vilket förfarande innefattar

generering av en signal som bringas att infalla mot

sensorelementet (6), samt

detektering av nämnda signal i nämnda mät- och styrenhet (10) efter påverkan av mätsignalen i nämnda sensorelement (6),

k ä n n e t e c k n a t d ä r a v att förfarandet dessutom innefattar bestämning av ett mått på längden hos nämnda optiska förbindelse (3) med utgångspunkt från en uppmätt tidsperiod som förflyter från genereringen av nämnda signal till detekteringen av nämnda signal.

9. Förfarande enligt patentkrav 8, k ä n n e t e c k n a t d ä r a v , att nämnda längdbestämning utnyttjas för identifiering av aktuell typ av sensorelement (6), varvid längden hos nämnda optiska förbindelse (3) väljes för att motsvara en specifik typ av sensorelement (6).

10. Anordning vid optiska mätsystem innefattande ett sensorelement (6) som är anslutet till en mät- och styrenhet (10) via en optisk förbindelse (3) och som är inrättat att avge en signal som utgör ett mått på en fysikalisk parameter (p) som påverkar sensorelementet (6), vilken anordning dessutom innefattar en ljuskälla (2) för generering av en mätsignal som bringas att infalla mot sensorelementet (6), samt en detektor (7) för detektering av intensiteten hos mätsignalen (B) i mät- och styrenheten (10) efter påverkan av mätsignalen i sensorelementet (6), k ä n n e t e c k n a d d ä r a v att den innefattar en semi-reflekterande anordning (12) för partiell reflektion av mätsignalen i en punkt längs den optiska förbindelsen (3) på förutbestämt avstånd till sensorelementet (6), varvid nämnda detektor (7) är inrättad för detektering av intensiteten hos den signal (A) som svarar mot nämnda partiellt reflekterade mätsignal, samt att den innefattar en utvärderingsenhet (9) för bestämning av ett mått på nämnda parameter (p) med utgångspunkt från intensiteten hos den partiellt reflekterade signalen (A) och intensiteten

hos mätsignalen (B).

11. Anordning enligt patentkrav 10, k ä n n e t e c k n a d d ä r a v , att nämnda sensorelement (6) innefattar en kavitet (6a) som är så utformad att optisk interferens uppstår vid inmatning av nämnda mätsignal i kaviteten (6a).

12. Anordning enligt patentkrav 9, k ä n n e t e c k n a d d ä r a v , att nämnda kavitet (6a) erhålles genom uppbyggnad av molekylära kisel- och/eller kiseldioxidskikt och ett etsningsförfarande.

13. Anordning enligt patentkrav 12, k ä n n e t e c k n a d d ä r a v , att nämnda kavitet (6a) erhålles genom att utnyttja ett bondningsförfarande.

111933 PA
2000-06-29

SAMMANDRAG:
Uppfinningen avser ett förfarande vid optiska mätsystem innefattande ett sensorelement (6) som är anslutet till en mät- och styrenhet (10) via en optisk förbindelse (3) och som är inrättat att avge en signal som utgör ett mått på en fysikalisk parameter (p) som påverkar sensorelementet (6), vilket förfarande innefattar generering av en mätsignal som bringas att infalla mot sensorelementet (6), samt detektering av intensiteten hos mätsignalen (B) i mät- och styrenheten (10) efter påverkan av mätsignalen i sensorelementet (6). Uppfinningen kännetecknas av att den innefattar partiell reflektion av mätsignalen i en punkt längs den optiska förbindelsen (3) på förutbestämt avstånd till sensorelementet (6), detektering av intensiteten hos den signal (A) som svarar mot nämnda partiellt reflekterade mätsignal, samt bestämning av ett mått på nämnda parameter (p) med utgångspunkt från intensiteten hos den partiellt reflekterade signalen (A) och intensiteten hos mätsignalen (B). Uppfinningen avser också en anordning för genomförande av detta förfarande. Genom uppfinningen medges mätning med ett optiskt tryckmätningssystem med effektiv kompensation för eventuellt förekommande felkällor.

(Figur 1)